Learning Target: I can read passages about the relationship between the electromagnetic spectrum and energy and then use the information gathered to answer comprehension questions.

FSI 8th Grade Science Reading for Meaning – The Electromagnetic Spectrum and Energy

When you stand outside on a sunny day, you feel the warmth of sunlight on your skin. That warmth is energy traveling from the Sun through space in the form of electromagnetic waves. But sunlight is just one small part of the **electromagnetic (EM) spectrum**—a continuous range of waves that carry energy even through the vacuum of space.

Every electromagnetic wave has **two key characteristics**: **wavelength** and **frequency**. Wavelength is the distance between two wave peaks, and frequency is how many waves pass a point in one second. These two properties are inversely related—**as wavelength decreases, frequency increases**. This relationship directly affects the **energy** of the wave. Waves with higher frequency have more energy because their electric and magnetic fields change direction more rapidly.

At the **low-energy end** of the spectrum are **radio waves**, which have long wavelengths (sometimes thousands of meters). These waves are used for communication and radar, but they don't carry enough energy to harm living tissue. **Microwaves**, with shorter wavelengths, transfer energy by causing molecules like water to vibrate—this is how your microwave oven heats food.

Next are **infrared (IR) waves**, which we sense as heat. **Visible light** comes next—a narrow band of wavelengths that our eyes can detect. Each color of visible light has a different wavelength: red light has the longest wavelength (lowest energy), while violet light has the shortest wavelength (highest energy).

Beyond visible light lie **ultraviolet (UV)** waves, which carry enough energy to cause sunburn or even damage DNA. **X-rays** have even more energy and can penetrate soft tissues but are absorbed by bone, allowing doctors to see inside the body. Finally, **gamma rays**—emitted by nuclear reactions and cosmic sources—carry the **most energy** and the shortest wavelengths of all.

When scientists compare the energies of EM waves, they often use data tables showing wavelength, frequency, and photon energy. For instance, gamma rays with a wavelength of 10^{-12}meters can have energies over a million times greater than visible light photons. This data supports the conclusion that **energy increases as wavelength decreases** across the spectrum.

Understanding this relationship helps engineers design technologies that safely use different parts of the spectrum—from **radio telescopes** scanning the cosmos to **medical imaging** tools that harness X-rays and gamma rays. By analyzing data across the EM spectrum, scientists can "see" invisible forms of light and reveal the hidden energy that powers our universe.

DOK 3–4 Multiple-Choice Questions

1. Based on the passage, which statement best explains why gamma rays carry more energy than visible light? (DOK 3)
A. Gamma rays are produced by the Sun, while visible light is not.
B. Gamma rays have shorter wavelengths and higher frequencies than visible light.
C. Gamma rays travel faster than visible light through space.
D. Gamma rays have larger amplitudes than visible light.

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2. Which data pattern would best support the claim that energy increases as wavelength decreases? (DOK 3)

A. Increasing wavelength corresponds to decreasing energy values.
B. Increasing wavelength corresponds to increasing frequency.
C. Decreasing wavelength corresponds to constant energy.
D. Decreasing wavelength corresponds to decreasing energy.

3. A scientist collects data on three EM waves: (DOK 3)

- Wave 1: 10^{-1}m wavelength
- Wave 2: 10^{-6}m wavelength
- Wave 3: 10^{-9}m wavelength

Which wave most likely has the greatest energy, and why?
A. Wave 1, because it has the lowest frequency.
B. Wave 2, because microwaves heat objects.
C. Wave 3, because shorter wavelengths correspond to higher energy.
D. All have the same energy because they move at the same speed.

4. If the energy of a wave doubles, what happens to its wavelength according to the data trends described? (DOK 3)

A. The wavelength also doubles.
B. The wavelength stays the same.
C. The wavelength is cut in half.
D. The wavelength increases exponentially.

5. Engineers designing airport security scanners must select waves that pass through clothing but not metal. Based on energy differences across the EM spectrum, which region is best suited for this purpose? (DOK 4)

A. Radio waves B. Microwaves C. X-rays D. Infrared waves

6. The passage states that violet light has the shortest wavelength within visible light. Which inference can be made about its energy compared to red light? (DOK 3)

A. Violet light carries less energy than red light.
B. Violet light and red light carry equal energy.
C. Violet light carries more energy than red light.
D. Violet light energy cannot be compared to red light.

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7. Suppose a new telescope detects EM waves with wavelengths shorter than gamma rays. Which hypothesis would best explain their extreme energy levels? (DOK 4)
A. They are new forms of radio waves created by galaxies.
B. They might originate from high-energy cosmic events like black hole collisions.
C. They must come from Earth's atmosphere.
D. They likely have lower frequencies than microwaves.

8. In the passage, why is the comparison between radio waves and gamma rays effective for illustrating the relationship between energy and wavelength? (DOK 3)
A. They both travel slower than visible light.
B. They represent the extremes of the electromagnetic spectrum, showing a full range of energy differences.
C. They both are visible to the human eye.
D. They are used for similar types of technology.

9. A data table shows the following photon energies: (DOK 3)

- Radio waves = 10^{-6}eV
- Infrared = 10^{-2}eV
- Visible light = 2 eV
- Gamma rays = 10^{6}eV

What generalization can be made from this data?
A. Energy decreases as wavelength decreases.
B. Energy remains constant across the EM spectrum.
C. Energy increases dramatically as wavelength decreases.
D. Energy fluctuates randomly across the spectrum.

10. A research team wants to reduce radiation damage from medical X-rays while keeping image clarity. Based on energy-wavelength relationships, which strategy would be most effective? (DOK 4)
A. Increase the X-ray wavelength slightly to reduce energy per photon.
B. Decrease wavelength further to improve image quality.
C. Increase exposure time to reduce total energy.
D. Switch to gamma rays for lower-energy imaging.

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